points out that if ω is less than Ω, the current is opposed to the electromotive force of the disk, and that therefore in this case "the chemical action is the source of the current instead of being an effect of it; and the disk by its rotation produces mechanical effect as an electro-magnetic engine" (or, as we now call it, a motor) "instead of requiring work to be spent upon it to keep it moving as a magneto-electric machine." If γ' be the current flowing, F the intensity of the field in which the disk revolves, r the radius of the disk, R the resistance of the circuit, W′ the rate at which work is done by the current on the engine, M′ the rate at which energy is spent by the battery, then the results—

$$\gamma' = \frac{r^2 F}{2R}(\Omega - \omega),$$

$$W' = \tfrac{1}{2} r^2 F \omega \gamma',$$

or

$$W' = \frac{\omega}{\Omega} M'$$

are given, and it is pointed out that the fraction of the "entire duty of the consumption which is actually performed by the engine is equal to ω/Ω." The ratio ω/Ω is the ratio of the back electromotive force of the motor to the total electromotive force of the generator, and is therefore the law of efficiency stated above in the words of M. Witz.

The examples worked out in the book are many of them highly instructive, and, so far as we can judge from the examination of a selected few, seem clearly and correctly dealt with. They are not merely numerical, but include in most cases the deduction from general theorems of formulas for particular cases, which are then illustrated by numerical problems in which results are expressed in C G.S. units. The value of these problems is enhanced by the fact that they are, as we have said, for the most part actual problems which have turned up in experimental or practical work. The subjects thus elucidated include magnetism, electrostatics, steady flow of electricity, electro-magnetism, dynamos, motors, and the distribution and transmission of electric energy. There can be no doubt that the book will prove very useful to teachers and students. Its only fault is that it leaves nothing for the student himself to do. A moderate number of unworked examples, on which he might test his grip of the subject, and power of applying principles, would have been very valuable. It is undesirable to spend very much time in solving mere arithmetical or algebraic conundrums, but enough must be done to acquire a fair amount of readiness and expertness of calculation; and of the great benefit derived from working out numerical examples of physical principles, there can be no doubt. We think, therefore, the author would do well to supply material for this in a future edition.

A. Gray.

BESANT'S DYNAMICS.

A Treatise on Dynamics. By W. H. Besant. (Cambridge: Deighton, Bell, and Co., 1893.)

THIS popular text-book has now reached a second edition, and contains several additions which have increased its size from 334 to 448 pages. A new chapter has been added on disturbed elliptic motion, which shows how the elements of an elliptic orbit are affected by small disturbances in the same plane. This chapter will serve as a useful introduction to the planetary theory, since the limitation of the problem to two-dimensional motion enables various difficulties, which arise from taking into account the longitude of the node and the inclination of the orbit, to be got rid of. The principle, upon which the method of the variation of the elements is based, is one to which students should be introduced at an early stage; but unless some simplification is made, the analysis becomes rather complicated. We are inclined to suggest that this chapter might be extended in a future edition.

The last chapter of the first edition has been amplified into two, the first of which deals with motion in three dimensions, whilst the second discusses several important problems relating to the motion of tops, discs, gyroscopes, &c.; and the book concludes with a new chapter on Lagrange's equations, together with several applications illustrating their use. To discuss any of the higher developments of this branch of the subject, including the Hamiltonian transformation, and the mixed transformation which in 1887 was for the first time given in a *complete* form by the author of this review, would probably be thought beyond the scope of an elementary work; but it would be well to bring out more pointedly the fact that the kinetic energy of a dynamical system can be expressed in several different forms, and that when employing Lagrange's equations there is only one form which it is permissible to use, viz. the Lagrangian form, in which the kinetic energy is expressed as a homogeneous quadratic function of velocities which are the time-variations of coordinates. Mistakes are frequently made upon this point; and it is most necessary to impress upon the minds of students that Lagrange's equations are double-edged tools, which are apt to cut the fingers of those who unskilfully handle them.

Dr. Besant has used the word *phoronomy* in the place of *kinematics*, and he has stated his reasons for so doing in a letter published in Nature, March 17, 1892. The word appears to be a good one, and has the merit of being classical, and not Teutonic; but notwithstanding occasional flights into the regions of radicalism, the ingrained conservatism of the English mind is so strong that it is by no means certain whether phoronomy will supplant a word which has long held the field.

One of the most satisfactory features of the work is that Dr. Besant has drawn marked attention to the principle of momentum. This principle is in some respects a more fundamental one than the principle of the conservation of mechanical energy; for the former principle is true in the case of viscous systems in which there is a conversion of mechanical energy into heat, whilst the latter does not hold good when internal friction or viscosity exists. The principle of linear momentum can be shown to be a direct consequence of Newton's second and third Laws of Motion; but doubts have been entertained whether the principle of angular momentum can be deduced from Newton's Laws without the aid of an additional hypothesis. The question, however, is far too recondite a one to be discussed in a review.

It is possible that some of those whom a recent correspondent in Nature has described as "the slug and the bug school" may object to the large amount of problems

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and examples which are contained in the text and at the end of the chapters. Persons whose curiosity is limited to finding out *what electricity does*, and adopt the unscientific attitude of considering it waste of time to try and ascertain *what electricity is*, and *why* it is capable of performing so many wondrous feats, may perhaps rebel against a system, one of whose objects is to train the mind to inquire into the *causes* of natural phenomena. It must be recollected that young men, who are just emerging from the schoolboy stage of existence, invariably find that Rigid Dynamics is a very difficult subject to master, and that a thorough knowledge of the principles of the subject, combined with analytical skill in applying them to natural phenomena, can only be acquired by working out a large number of problems and examples. It is also an excellent plan for students to work out the same problem (for example, the motion of a top) by various methods, and to study the different results obtained by each; for they will thereby not only obtain analytical skill, but will learn that their symbols, instead of representing mere mathematical quantities, are the embodiment of important scientific facts.

A. B. BASSET.

INSECT PESTS.

Our Household Insects: an Account of the Insect Pests found in Dwelling-houses. By Edward A. Butler, B.A., B.Sc.Lond., author of "Pond Life," "Silkworms," &c. (London and New York: Longmans, Green and Co., 1893.)

MR. E. A. BUTLER has done useful service to the cause of popular entomology by reprinting the present series of his contributions to *Knowledge* in book form. Not very many species are discussed, but these seem to comprise most of the principal insect pests belonging to the various orders of insects which infest our houses, and attack ourselves or our property.

As insects (exclusive of insect-parasites) attack all kinds of dead or decaying animal and vegetable matters, and play the part of general scavengers, nothing is exempt from their ravages. Books are particularly subject to their attacks; and many of their enemies are noticed by Mr. Butler. We remember once being much amused by an account of a book-worm, which was ridiculed by a writer in a bibliographical magazine, as being evolved from the describer's own consciousness, but which was really fairly recognisable as applicable to *Lepisma saccharina*, the common silver-fish. But the critic regarded the book-worm as necessarily a small grub or beetle (we forget which), and displayed his own ignorance of entomology accordingly. Prof. Westwood once named a minute beetle, which had done much mischief to the cover of a book, *Hypothenemus eruditus;* and specimens of books damaged by insects may be seen in one of the cases in the public insect-room at the Natural History Museum, South Kensington. We believe that Mr. Zaehnsdorf, the well-known book-binder, has also formed a collection of the book-pests which he has met with in the exercise of his vocation. We may add that the Arabs sometimes write the name Kabikaj, said to be that of a genius who presides over insects, on their manuscripts, in order to protect them from the ravages of his subjects.

There is no doubt that insects of various kinds get mixed with human food from time to time; but we imagine that the passage which Mr. Butler quotes from Curtis's "Farm Insects," relating to maggots in cocoa-beans, is somewhat out of place at the end of a chapter on beetles, for we have good reason to believe that the insect to which Curtis alluded was not a beetle, but a moth of the genus *Ephestia.*

The seven plates of magnified insects and their structure, and the numerous woodcuts, add much to the usefulness of the book. Clear definitions, and accurate demonstrations, are extremely useful in entomology, not merely to beginners, but even to more advanced students, who often find much difficulty in obtaining the necessary explanations of the characters and terminology, when they take up the study of a group of insects with which they were not previously familiar.

The insects which Mr. Butler discusses may be divided into three classes: those which really cause serious destruction to property, as the clothes-moths and various kinds of small beetles; those which are rather troublesome and annoying than destructive, such as the flies and wasps; and those which attack man himself. Among the latter are the lice, which the increase of cleanliness has fortunately rendered rather unfamiliar objects to the better classes in recent times. Yet they are highly interesting creatures, from many points of view, and several entomologists have not scrupled to make a special study of them; among others, Denny, who wrote an elaborate monograph on the British species, illustrated with twenty-six coloured plates; and the old Dutch naturalist, Van Leeuwenhoek, who actually reared a brood in a stocking on his own leg! We think the figure of the proboscis of a louse, which Mr. Butler copies from the Danish entomologist Schiödte, on p. 332, will be new to most of his readers. But there is a curious omission of a necessary explanation in Mr. Butler's observations, in the following passage:—

> "Man is not exceptional among mammals in harbouring these vermin; he is but in the same category with the rest, for it seems to be the rule, from elephant to mouse, largest to least, that some member of this group of parasites should be attached to each species; and even aquatic animals, such as the seal and walrus, do not evade their attacks."

Surely Mr. Butler, to avoid being misunderstood, should here have stated that the presence of a true louse on seals is quite an exception as regards marine animals, and that the so-called "whale-louse," and similar parasites, are not true lice, or even insects at all, but parasitic crustacea.

Our author mentions the fact of colonies of fleas having sometimes been found on sandy sea-shores, and wonders what they can find to eat there. But although certain species of fleas are attached to different species of animals, they are perhaps not so particular about their food as is generally supposed. In all warm countries it is very common to find colonies of fleas camping-out in the open; and the late Mr. F. Smith once recorded an instance of a suburban garden, in which a particular bed was swarming with dog-fleas; no particular dog being mentioned as the probable origin of the invasion. In the Western States of America, the "wild fleas," as the late

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